Dynamics and glass formation of aluminate liquids

An invited talk

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We present our recent findings regarding the dynamics of calcium aluminates (CAs) in the regions of both the stable liquid and the metastable supercooled liquid, which were achieved by measuring the change of both viscosity and density with temperature using an advanced aerodynamic levitator (AL). This AF is capable of accessing the liquid dynamics at temperatures up to 3000 K, and in a broad range of supercooling (ΔT up to 500 K) for the studied calcium aluminates. Furthermore, AL enables vitrifying extremely poor glass-forming systems like aluminates due to the ultrafast quenching. Based on the temperature scaling of viscosity we observed a signature of the fragile-to-strong transition in all the five glass compositions with different CaO/Al_2O_3 ratios. The origin of this dynamical feature has been revealed by determining the responses of structure, density, glass transition temperature (T_g), liquidus temperature (T_m), crystallization temperature (T_c) to the variation in CaO/Al_2O_3 ratio. These responses are considerably different from those reported in literature. For instance, both T_g and T_g/T_m exhibit a threshold in the eutectic composition of $12CaO{\cdot}7Al_2O_3$. There is an implication that the fragile-to-strong transition could be associated with the occurrence of oxygen triclusters and 5-coordinated aluminum. Furthermore, we discuss the structural origin of the ultralow glass-forming ability of CA systems.

Keywords: calcium aluminate, dynamics, levitator, viscosity, fragile-to-strong transition